Cooper Creek Instream Flow Study: Final 2003 Study Plan

Cooper Lake Project (FERC No. 2170)

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Prepared for
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Introduction

The Cooper Lake Hydroelectric Project (Project), Federal Energy Regulatory Commission (FERC) Project No. 2170, is owned and operated by Chugach Electric Association, Inc. (Chugach). The Project was originally licensed by FERC in May 1957, and the current license term expires at the end of April 2007. Chugach is conducting studies to develop information needed to determine the effects of the Project on environmental resources. Information from the resource studies will be used to help identify appropriate protection, mitigation, and enhancement measures that will be proposed in Chugach's final application to relicense the Project, which must be filed with FERC no later than April 30, 2005.

This study plan outlines the purpose and protocol both for collecting data to support an instream flow study in Cooper Creek and for performing that study. Field investigations were conducted during the periods September 3–7, 2002 and October 3–6, 2002 for a total of 9 field days. A 1.6–kilometer section within the canyon reach was not formally surveyed and has been rescheduled for completion in 2003. This work is described in the Cooper Creek Aquatic Habitat Analysis study plan and report, and will be used in the selection of transect locations. In addition, sites for temperature and flow monitoring were established on Cooper Creek above and below Stetson Creek, on Stetson Creek (temperature only) near its confluence with Cooper Creek, and in Cooper Lake (see Stream Flow and Water Quality study plan). This instrumentation was installed in September 2002.

This study plan reflects input from interested agency representatives (representing the U.S. Forest Service, U.S. Fish and Wildlife Service, National Marine Fisheries Service, Alaska Department of Fish and Game, and Alaska Department of Natural Resources) who met to discuss technical details of the Cooper Creek instream flow study at an Instream Flow Workshop, hosted by the study leads at HDR Alaska, Inc., on December 5, 2002. This group constitutes the IFIM Review Team, as described in the Study Methodology section. In addition to discussing specific methodologies and technical details regarding the Cooper Creek instream flow study, the IFIM Review Team also designated a transect selection team[1] to work out further technical aspects of the instream flow study as the study planning and implementation proceeds.

Project Background

The Project was licensed in 1957 and construction was completed in 1959. Cooper Lake Dam was constructed at the natural outlet of the lake to Cooper Creek, and all outflow is diverted through the intake structure located on the east side of the lake to the powerhouse on Kenai Lake.

Prior to dam construction, the outflow of Cooper Lake to Cooper Creek was an average of about 100 cfs. The average flow of Cooper Creek at its mouth was 130 cfs. Historic data suggest that stream temperatures may have been higher before dam construction at times of the year when

[1] The "IFIM transect selection team" consisted of designated experts from the Alaska Department of Fish and Game and the U.S. Forest Service, along with the study leads from HDR Alaska, Inc. and Northern Ecological Services. The first meeting of this team was conducted on March 26, 2003. A field trip was scheduled for early in the 2003 field season, and will involve representatives of all interested stakeholders as well as those on the IFIM transect selection team.

relatively warm lake surface water flowed into Cooper Creek, than under existing conditions. Prior to dam construction, the lake surface elevation fluctuated approximately 1 to 2 feet during an average year and had an average elevation of 1,168 mean sea level (msl) (USFS Cooper Creek Watershed Analysis, 2002). The reservoir now has a typical annual fluctuation of about 15 feet and a normal maximum operating level of 1,194 feet msl. Under the current operating regime, the reservoir is typically at its lowest elevation in April–May, and then slowly rises until its highest level in August–December. Average outflow through the powerhouse is approximately 100 cfs. Maximum powerhouse discharge at any time is 380 cfs, and the minimum discharge is 0 cfs.

Historical and current flow data are available for lower Cooper Creek and Stetson Creek. Some historical and currently recorded temperature and water quality data are available for Cooper Creek, and temperature profiles have been measured in Cooper Lake in the past.

Study Purpose and Goals

The purpose of the instream flow study is to determine the potential effects of a range of flows on fish habitat, water temperature, and sediment transport in Cooper Creek.

Study Area Description

The study area will include the entire length of Cooper Creek from its mouth at the Kenai River up to Cooper Lake Dam. The stream is divided into five logical segments as follows:

A. Alluvial Reach: lower, alluvial fan reach extending from the mouth of Cooper Creek up to the mouth of the canyon - relatively homogeneous reach dominated by riffle habitats (0.7 mile [1,128 m]).
B. Canyon Reach: reach extending from the lower canyon mouth up to the confluence with Stetson Creek - characterized primarily by a long series of step pools separated by riffles with occasional cascades and bedrock chutes (2.6 mile [4,200 m]).
C. Stetson Reach: mouth of Stetson Creek upstream to the lower impassable falls - characterized by low flow and diverse habitats (0.9 mile [1,443 m]).
D. Falls Reach: reach extending from the lower impassable falls to the upper impassable falls - characterized by a closely linked series of significant falls and cascades (0.2 mile [348 m]).
E. Lake Reach: reach extending from the upper falls to the Cooper Lake dam - characterized by low flow and dense vegetation with most of reach consisting of closely linked shallow beaver ponds and disturbed channel (0.3 mile [417 m]).

Study Methodology

The Instream Flow Incremental Methodology (IFIM), developed by the U.S. Fish and Wildlife Service (Bovee, 1982), was selected as the methodology for completing the instream flow study for Cooper Creek. IFIM is a multidisciplinary problem-solving process used to develop an incremental approach for evaluating the effects of alternative stream flows relative to the requirements for a target species, lifestage, or use. The IFIM study will generally follow recommended procedures and methods given in Bovee, et al. (1998) and related IFIM publications. The major components are described in the sections below.

Study Framing

The study framing component is the most crucial part of every IFIM study. The undertakers of the study and the stakeholders (in this case, relicensing participants) should be in agreement on all major aspects of the study before it begins. To this end, the IFIM Review Team was established to allow a forum for the stakeholders and applicant to exchange information and ideas, review and discuss the study and study plans, and establish consensus on important issues.

This component of IFIM includes problem identification, selection of the appropriate methodologies, identification and selection of baselines, and an agreed-upon scope of work.

Problem identification has already been performed. Chugach supplied all interested parties with an Initial Consultation Package for all aspects of the relicensing process and solicited comments. Several responses from relicensing participants included requests for an instream flow study on Cooper Creek, and detailed three major components of Cooper Creek instream flow that are potential problems – fish habitat, stream temperature, and sediment transport.

Selection of methodologies also has already been performed. IFIM was selected as the instream flow methodology within which other components may be selected. To adequately address the complexity of the Cooper Lake/Cooper Creek system, the three major instream flow issues listed above must be addressed with state of the art computer models. The Physical Habitat Simulation System (PHABSIM) (Milhous, et al., 1989) was selected as the software for modeling fish habitat in Cooper Creek. The Stream Network Temperature Model (SNTEMP) (Theurer, et al., 1984) was selected as the software for modeling water temperature in Cooper Creek. For analyzing sediment transport in Cooper Creek, existing embeddedness conditions and geomorphic response will be analyzed. If embeddedness conditions indicate sediment deposition is a prevalent problem in Cooper Creek due to the project-related decrease in flow, a sediment transport analysis will be undertaken that combines standard incipient motion models with the SAM sediment transport model (Thomas et al., 1998) to determine sediment transport threshold flows in Cooper Creek.

Identification and selection of baselines is an important issue that, like the above topics, also requires agreement from the stakeholders before data collection begins. The IFIM Review Team discussed This topic in detail in the Instream Flow Workshop, hosted by HDR on December 5, 2002. The agenda included the following items that pertain to identification and selection of baselines:

- Cooper Creek habitat inventory survey and future work
- Target species & lifestages
- Development/borrowing/use of Habitat Suitability Criteria (HSC)
- Stream reaches to be modeled
- Data collection and reduction methods
- Hydrology – what hydrograph is used to develop a habitat time series
- Stream temperature data
- Sediment model components

- Milestones or target dates

The results of the discussions of the above baselines are identified in later sections of this study plan.

Finally, a **scope of work** was the end product of the Instream Flow Workshop. The study plan (this document) serves as the master scope of work, and will generally describe all work that will be performed in the instream flow study. More detailed descriptions for selected study components may be desirable as the study evolves. Such additions to the scope of work would be distributed to the relicensing participants throughout the term of the study.

Field Data Collection

Collectively, a large amount of data is required as input to the three models included in this study. Some data may be general regional data, such as the relative humidity and percent sunshine parameters of the SNTEMP model. However, most of these data are field data specific to Cooper Creek. Such data, including flow, water temperature, and physical habitat, must be collected at locations that are strategically selected based on, among other factors, the habitat types and stream reaches they represent.

Stream Habitat Description

The aquatic habitat component of Cooper Creek will be thoroughly mapped and analyzed prior to the collection of physical stream data. The location, abundance, and continuity of the different micro-, meso-, and macrohabitat units in the creek will dictate the selection of stream transects. The efficacy and accuracy of the fish habitat and sediment transport components specifically, and the IFIM study in general, is inherently linked to the selection of transects that effectively represent their respective habitats. Aquatic habitat information will be collected as described in the Cooper Creek Aquatic Habitat Analysis study plan. The aquatic habitat analysis was initiated in 2002 and will be completed in 2003.

Model Input Data Collection

IFIM study sites will be selected using the mesohabitat typing method described in Bovee (1997), and transects within the study sites will be selected also using methods described in the same document. Measured microhabitat data will include channel geometry, water surface elevation, stream velocity, channel substrate size, and cover, as well as detailed sediment properties at selected locations. Transects will be selected for the most common habitat types. The IFIM study sites were selected in the transect selection meeting on March 26, 2003. The transect selection meeting included members of the IFIM Review Team that were identified during the December 5 Instream Flow Workshop. Site selection will continue with a field trip early in the 2003 field season with a small group of members of the IFIM Review Team.

As with any model, the quality of the output is dependent upon the quality of the input. An important component of IFIM data collection is the measurement of water surface elevations at transects at a range of at least three flow discharges. Ideally, the water surface elevation measurements would be taken at flows very near the maximum and minimum simulated flows to eliminate or reduce the need for extrapolation. In Cooper Creek, this may be possible for the lowest simulated flow, but due to restricted access this will likely not be possible for most transects for the high flows. Water surface elevations may be collected at a few transects in the Alluvial Reach that may be accessed from the adjacent land, and at any transects in the Canyon or Stetson Reaches accessible by helicopter. Collection of data during yearly minimum and maximum flows is dependent on weather and snow cover conditions. The collection of data near the minimum and maximum simulated flows will also be limited by the 2003 water year. If the hydrologic regime in Cooper Creek does not provide a bulk of the flows that will be modeled because of an abnormal water year, the contingency plan, discussed in the Schedule section of this document, will be put into effect.

Presently, continuous stream flow and water temperature data are being collected at three locations and air temperature data are being collected at one location in Cooper Creek. These data will continue to be collected and monitored in 2003, and the data will be used in the data analysis and modeling component of the IFIM study. Methodology and station locations are described in the Stream Flow and Water Quality Study Plan.

Habitat Suitability Criteria Collection and Analysis

Selection of Evaluation Species and Life History Stages

Appropriate fish species and life history stages to be used in the evaluation of habitat changes that might occur with various flow regime alternatives were discussed by the IFIM Review Team at the December 5 Instream Flow Workshop. The IFIM Review Team selected the following species and life history stages for use in the analysis:

Selected Species/Lifestages	
Dolly Varden	**Rainbow Trout**
Spawning	Spawning
Juvenile rearing	Juvenile rearing
Adult non-spawning	Adult non-spawning
Chinook Salmon	**Coho Salmon**
Spawning	Spawning
Juvenile rearing	Juvenile rearing

Development of Habitat Suitability Criteria

The only fish species currently utilizing Cooper Creek to a significant degree is Dolly Varden. Habitat suitability criteria (HSC) for Dolly Varden spawning and rearing will be developed from site-specific data collected on Cooper Creek in 2003. The frequency method for determining probability of use curves will be employed as described by Bovee and Cochnauer (1977). Data pertaining to Dolly Varden spawning habitat will be collected during fall surveys of spawning locations in Cooper Creek as described in the Cooper Creek Fish Resources Study Plan. At each observed spawning location, depth, mean velocity, and substrate type will be determined, with depths and velocities measured at the upstream lip of the redd. Rearing habitat preferences will be evaluated during the mid-summer fish resource investigation described in the Cooper Creek Fish Resource Study Plan. Depth, velocity and substrate type will be determined at specific locations where juvenile Dolly Varden are captured or observed. The goal will be to obtain 100 observations in the Stetson Reach and 100 observations in the combined Canyon and Alluvial Reaches. Since adult Dolly Varden enter Cooper Creek primarily for spawning purposes, direct determination of adult non-spawning habitat preferences will probably not be possible in Cooper Creek. Rather, adult preferences will be determined by reviewing available probability-of-use curves developed for other Alaskan streams, conferring with biologists familiar with Dolly Varden life history in the Kenai River drainage, and combining the information to develop appropriate suitability criteria for Cooper Creek. It should be noted that adult Dolly Varden might select habitats based on seasonal food availability rather than stream physical characteristics; consequently, the use of probability-of-use curves for this life history stage may be somewhat artificial.

The other evaluation species are not currently found in Cooper Creek in significant numbers; therefore suitability criteria must be obtained by using probability-of-use curves developed elsewhere or by constructing curves based on best professional judgment. A cursory review of existing HSC developed from measurements in Alaskan streams, combined with follow-up discussion at the Instream Flow Workshop, indicated that suitability criteria likely exist for chinook and coho salmon spawning and rearing that can be applied to Cooper Creek. The general procedure for developing suitability criteria for the species and life stages not present in Cooper Creek will involve the following steps:

1. Review HSC (probability-of-use curves) developed for other IFIM studies on streams in Alaska and in the Pacific Northwest.
2. Select sets of criteria that appear to be most applicable to Cooper Creek based on stream location, size, channel type, and other physical characteristics.
3. Initiate a review of the selected criteria by biologists familiar with Cooper Creek and the Kenai River drainage. Modify the criteria as appropriate per recommendations from the IFIM Review Team.
4. If no measured criteria exist for a specific life stage, then probability-of-use curves will be constructed from literature and professional judgment. The curves will be subjected to review by the IFIM Review Team and modified as appropriate.

Consensus among the IFIM Review Team members will be required for all HSC prior to IFIM modeling.

Data Analysis and Modeling

Collected data will be reduced and prepared for entry into the habitat, temperature, and if necessary, sediment transport models. The time periods and intervals to be modeled will be selected to best represent the flows, temperatures, and patterns and timing of target fish species, and will reflect input and alternatives requested by the IFIM Review Team.

As described previously, physical data will be collected for the models, whenever possible, at common transects that will be selected based on their representation of habitat types and stream reaches. While the models are entirely different, these common transects will help "frame" the channel geometry in model space in a similar fashion. This will greatly help in the synthesis of model output, as will be described in a section to follow.

The models selected for use within the IFIM to describe physical attributes in the Cooper Creek system are described in detail below.

Stream Habitat

The Physical Habitat Simulation System Reference Manual, Information Paper 26 (Milhous, et al., 1989), states "the purpose of the Physical Habitat Simulation System is to simulate a relationship between streamflow and physical habitat for various life stages of a species of fish or a recreational activity." PHABSIM is a suite of models that combine stream flow hydraulics with fish biological parameters to create an index of habitat available to a species or lifestage of fish in a user-specified reach of stream. The "virtual stream" in the PHABSIM environment uses cross-sections that were measured at specific locations and include multiple stream habitat types and/or stream reaches.

PHABSIM includes three modules: hydraulic simulation, habitat suitability curve building, and habitat simulation. The habitat suitability curve building module will have already been accomplished prior to PHABSIM modeling, and was described in an earlier section. The hydraulic and habitat simulations are described in more detail below.

In PHABSIM, a river reach is defined by a number of cross-sections spaced a sufficient distance apart to capture the hydraulic characteristics of the reach. This distance can range from a few meters to hundreds of meters, depending on the lengths of continuous habitat types within the reach. The purpose is to develop a set of depths, water surface elevations, and cross-section-averaged velocities for all cross-sections in the reach at a range of discharges. The user begins this process by entering the cross-section bed geometries and water surface elevations (stages) for the calibration discharges. PHABSIM must then develop a relationship between stage and discharge for the reach. Once this relationship is determined, depth at any point along the channel cross-section can be determined by subtracting the bed elevation from the stage. Three approaches exist to determine stage-discharge relationships (hydraulic models within the PHABSIM software): a log-log linear regression (IFG4), use of Manning's equation (MANSQ), and a standard step-backwater calculation (Water Surface Profile; WSP). Either one or all three approaches can be used in a reach for different discharges, depending on which approach(es) provides the best calibration of modeled and observed parameters (water surface elevation and velocity). Once a stage-discharge relationship has been determined using IFG4, MANSQ, and/or WSP, the IFG4 model is used to determine a stage-velocity relationship. An important output of hydraulic modeling in PHABSIM is the calculation of the area of flow at each cross-section in the study reach. The areas are calculated by adding the areas of a number of user-specified vertical cells that are determined by the number of points used to create the cross-section geometry. The corresponding depths and velocities of each of the cells are also calculated and forwarded to the habitat modeling module of PHABSIM.

The habitat models in PHABSIM combine the output from the hydraulic simulation and the HSC curves to develop a measure of available habitat as a function of discharge. In doing so, PHABSIM assumes that the individual fish will select the most desirable habitat condition first, and when those most desirable locations are filled, will select a less desirable condition nearby. Each cell in a cross-section is evaluated independently. Several approaches exist in PHABSIM for habitat simulation: the HABTAE program calculates weighted usable area (WUA) for each reach and cross-section; the HABTAM program simulates conditions in which fish can migrate laterally within a cross-section in order to make use of the available WUA when there is a change in discharge; and the HABEF program calculates the physical habitat considering the conditions at two stream flows and/or for two lifestages or species of fish.

The output from PHABSIM is an index of WUA for a number of flows and flow regimes. Care must be taken not to interpret PHABSIM output as absolute numbers, rather as a simulated index of probable trends in available habitat as a function of flow and flow regimes.

The primary limitations of PHABSIM are its reliance on HSC that, in this case, may not be developed from Cooper Creek fish. Care must be taken in the selection of HSC. Another limitation is the inevitable loss of richness that comes from breaking a 4.6-mile (7.5-km) creek that contains extremely varied microhabitat throughout its length into tens of cross-sections to represent a few habitats. The most effective way to reduce the magnitude of these limitations is to carefully plan and wisely choose HSC and cross-sections that best represent the fish and physical habitat, respectively, of Cooper Creek.

Stream habitat modeling will be limited to the Alluvial, Canyon, and Stetson Reaches as agreed upon by the IFIM Review Team at the Instream Flow Workshop. However, stream habitat will be analyzed as a function of flow outside of the PHABSIM environment for the Falls and Lake Reaches for each alternative.

Temperature

The Stream Network Temperature Model, SNTEMP, models temperatures in a stream as a function of hydrologic conditions, riparian and topographic shading, and meteorological conditions. The one-dimensional model assumes steady flow, complete mixing, and requires daily mean temperatures for input variables. SNTEMP is a stream network model with temporal and spatial components, and calls upon output from companion programs, SSSOLAR and SSSHADE, to provide data on short-wave radiation and shading percentages. SNTEMP has a text interface and is a public domain model.

SNTEMP, a DOS-based program, uses an energy balance equation to calculate mean water temperature as a function of measured input variables. Maximum temperatures are calculated from the modeled mean temperatures using an algorithm; meaning calculated maximum temperatures are not physically based.

The SNTEMP model utilizes six input files that include measured data and two system control files. The **Study File** includes the locations and types of nodes that define the stream network system, as well as locations in the network where output is required. The **Geometry File** provides a network definition of the modeled stream, the site location and the stream geometry (e.g. channel width, depth, and gradient). The **Shade File** includes data for parameters that contribute to the shading of the stream due to topographic and vegetative conditions. The **Time Period Data File** is primarily used by SNTEMP as a system file but includes two parameters that are used in the determination of incoming solar radiation: the dust coefficient and ground reflectivity. The **Meteorology Data File** includes all remaining meteorological data for the study reach for each day in the study period. The **Hydrology Data File** provides the mean daily stream flows and temperatures for the modeled streams and all tributaries to the stream network for each day in the study period. The **Hydrology Node File** is a system control file that contains information needed by the program on where hydrology data are required. The **Job Control File** is another system control file that contains information required by the program that defines the size of the network, the extent of output desired, years of data simulated, node counts, calibration factors, and file names.

Daily mean and maximum instream temperatures should be collected at various locations in the study reach during the modeling period for use in model calibration and validation. Model output is requested at the locations of the temperature monitoring stations. Built-in calibration coefficients, located in the Job Control File, as well as selected input data, can be adjusted to achieve model calibration. These measured temperature data, as well as data collected from other locations in the study reach, can be used for validation to assess model efficacy. The output from the SNTEMP model is a table of average and maximum modeled water temperatures for each day in the modeling period at user-requested locations in the modeled stream network.

Temperature modeling will be done for all reaches of Cooper Creek for all alternatives. Geometry of the Lake Reach is problematic, as most of this reach is impacted by beaver dams. For this reach, assumptions will be made for each alternative on whether the dams will remain standing, or if the new flow regime will not allow the dams to remain. The geometries of the remainder of the reaches will not be changed between alternatives.

Sediment and Geomorphic Analyses

As is typically the case with dams, the construction of Cooper Lake Dam presumably altered the sediment regime of Cooper Creek. However, unlike many typical situations, the dam probably did not cut off an important source of sediment from Cooper Creek. The historic main source of Cooper Creek flow was the outlet of Cooper Lake, which likely provided relatively sediment-free water into the stream. The majority of sediment input to Cooper Creek likely was provided then, and still is today, by canyon runoff and hill slope processes. However, less flow exists in Cooper Creek today to transport the inflow of sediment.

This situation invites the question, “how does flow regime affect sediment deposition and sediment transport in Cooper Creek?” This question can be investigated using collected data for current conditions, and from these data, predictions can be made for alternative flow regimes. These predictions can help identify the timing, magnitude, and duration of flood flows that provide sufficient energy to transport the existing bed load. Given the streambed gradation at a location with known geometry, a discharge can be determined that will transport different sizes of substrate. The timing, magnitude, and duration of discharges in a given alternative can be analyzed to assess the sediment transport qualities of the flow regime.

Step One – Assess Existing Conditions

The first step in this process is to collect bed material samples in the pools and riffles of selected reaches. One sample will be taken at each IFIM study site in the anadromous reaches, and at two locations each in the Falls and Lake Reaches. One survey method is the Wolman Pebble Count, recommended by the USFS, and a widely accepted method to estimate particle size distributions of alluvial bed material. Traditionally, pebble count surveys are taken by cross-section. However, pebble count surveys can also be conducted longitudinally, "zigzagging" across the river channel. In addition, Wolman Pebble Meters can be used to determine intermediate axis lengths. This method was used in the Aquatic Habitat Survey and is described in detail in the Cooper Creek Aquatic Habitat Analysis document (see attachment to final Cooper Creek Habitat Analysis study plan).

A rapid assessment method will be developed to visually qualify the level of embeddedness of gravels at each of the IFIM cross sections. Embeddedness (E) of gravels at up to approximately eighteen cross sections will be more closely quantified using methods described in Bunte and Abt (2001) by measuring approximately 100 clasts per section with sizes between D_{50} and D_{100} (D_t) to determine the protrusion above (D_f) and depth below (D_e) the level of the fine-grained sediment (embeddedness, $E = D_t/D_e$). These data will also be used to verify the visual rapid assessment results. At each of the cross sections, bulk samples and photographic record will be collected of existing substrate conditions. Bulk samples will be collected using either a shovel in exposed gravel deposits or with methods such as the barrel or McNeil type samplers in submerged gravels as described in Bunte and Abt. The bulk samples will be separated into armor layer and subarmor layer components as appropriate, sieved separately and results used in the sediment transport analysis described below.

A report will be produced describing the embeddedness features of the measured transects. In the event that field measurements of existing stream substrates indicate that embeddedness of the existing channel does not create a negative condition for spawning gravels, step two of the sediment transport study will not be performed.

Cooper Creek is responding to the change in flows following construction of Cooper Lake Dam. Flows from Stetson Creek and other tributaries more strongly influence flows and the associated geomorphologic condition along Cooper Creek. The geomorphic response to the current hydrologic regime will be investigated at a planning level. Regime equations and dominant discharge relationships will be used to estimate a range of channel configurations that are in dynamic equilibrium with the current hydrologic regime. The purpose of this analysis will be to understand the ultimate stream geomorphic condition that is dynamically stable and the habitats it will be able to sustain. A technical memorandum will be issued that describes this investigation.

Step Two – Sediment Transport Analysis

If step one indicates that embeddedness has created a negative condition in the existing channel, a sediment transport analysis will be performed based on collected data. Step two will assess the sediment transport potential of the existing substrates. The initial step of the sediment transport analysis will be to calculate the incipient motion particle size using the Shields equation (e.g., Julien, 1995). For gravel- and cobble-bedded streams, a typical value for the dimensionless Shields number is $t^* = 0.030$. Investigations by Buffington and Montgomery (1997) of historic data sets used by various researchers to develop values of the dimensionless Shields number will be reviewed for a more appropriate value. Incipient motion particle size analysis provides the size of particle at the threshold of mobility only. Larger particles would be expected to remain in place whereas smaller particles would be expected to be mobilized. Incipient motion calculations provide no information on the rate of transport of particles.

The second part of the sediment transport analysis will be the calculation of potential sediment transport discharge rates by size classes. The U.S. Army Corps of Engineers SAM at-a-station sediment transport model (Thomas et. al., 1998) will be used at up to five cross sections per each of the five reaches along Cooper Creek (approximately 18-sections, total). The SAM model has twenty sediment transport functions for the estimation of sediment transport discharge potential. Of these equations, there are between three and five equations developed for gravel-bedded streams. The gravel-bedded sediment transport equations will be used to develop rating curves of stream flow versus sediment transport potential. (The implicit assumption is that these equations will be representative of larger sized substrates that may be present along Cooper Creek.) The rating curves will be compared to the results of the incipient motion particle size analysis to estimate threshold flow conditions at which the armor layer becomes mobilized. SAM does not directly predict depths of aggradation or degradation.

The objective will be to determine the flow magnitude required to mobilize the armor layer, thus exposing fine-grained sediments for mobilization as bed and wash loads. Flow duration relative to magnitude will be estimated based on sediment discharge rates of the fine-grained sediments and length of time estimated to flush through the system.

One complicating factor in the sediment transport analysis is that in late October 2002, a large flow event in Cooper Creek likely flushed much of the existing sediment out of the system. This event, a mean daily flow of 429 cfs with a maximum recorded flow of 779 cfs, was the largest daily average flow in Cooper Creek on record since 1961. While sediment was likely moved from the stream gravel in pools and riffles, large valley runoff and massive landslides introduced new sediment into the system. Much of the sediment likely settled on the stream bottom during the receding limb of the flood event, and average flow in Cooper Creek has not been higher than that seen on October 29, 6 days after the peak of the Cooper Creek flood hydrograph. In the aquatic habitat inventory, several Wolman Pebble Count surveys were conducted at locations throughout Cooper Creek; these can serve as important baseline data, and Wolman surveys conducted in the same locations in 2003 can be compared to the pre-flood data.

Synthesis

The habitat and temperature models will be run for the same time periods, and may also have additional time periods depending on the objective of the model. In addition to similar model time periods, the flow regimes modeled in these time periods will be the same between the models. There will likely be several flow regime alternatives modeled. The results of the models and the sediment and geomorphic analyses will be compared both between flow regimes for a single model, and between models for a single flow regime. The results of the models and subsequent analysis will be given in a final instream flow report.

Technical Memoranda

Several technical components of the IFIM study merit explanation of the methods or techniques used. Therefore, several technical memoranda will be distributed following completion of the components they describe. The memoranda include:

- Cross-section selection and data collection
- Habitat suitability criteria development
- Data aggregation, including computation of WUA
- Synthesis of habitat time series
- Temperature modeling
- Sediment:
    - Embeddedness
    - Geomorphic response
    - Sediment transport, if necessary

Schedule

The 2003 instream flow study schedule, discussed at the Instream Flow Workshop, will be refined in the spring of 2003 before field work begins. A preliminary schedule follows:

2003 (***Please note that field dates are tentative and depend on hydrologic, ground, and weather conditions***)

March 26 – IFIM transect selection team meeting; preliminary selection of study sites.

April – Final Version of Instream Flow Study Plan and schedule delivered to relicensing participants.

April - May – IFIM transect selection field trip; field selection of IFIM study sites and transects.

April - May – High flow water surface elevation data collection where possible.

May – IFIM Review Team meeting

June – Complete stream habitat survey. Intermediate flow water surface elevation data collection and complete transect data collection.

July – Collect intermediate flow data at IFIM cross-sections.

October – Collect low flow data at IFIM cross-sections.

November – Begin model runs.

2004

To be developed in Fall 2003, as needed to complete study tasks.

Contingency Plan

The field schedule was set based on historical dates of ice-free water surfaces and the historical flow record. The schedule is subject to change if stream flows and ice and snow conditions do not conform to historical averages.

Previous experience of working in Cooper Creek has shown that safe data collection conditions exist at approximately a measured flow of 120 cfs or less at the USGS gage located in the alluvial reach. This gage is a “real time” gage, and the flows at the gage location can be accessed via the internet. Cooper Creek flows, as well as developing weather patterns, will be considered before a field trip is commenced.

If a scheduled field trip must be postponed due to flow, weather, or ice and snow conditions, the field trip will be moved to later in the season. The data collection schedule is truly only bounded by hydrologic conditions, rather than calendar time. If not all data are collected in the 2003 field season, modeling will begin as scheduled with the collected data and data collection will resume in 2004, and the models will be refined to include the newly collected data.

It is recognized that the study area is far from being a controlled environment; it is truly a dynamic system and is constantly subject to changes in its hydrology, geomorphology, and geometry due to extreme events. The recent flood in late October 2002 rearranged landforms and the stream itself, and caused numerous landslides and movement of sediment, rocks, and wood in the canyon. This event, a daily average flow of 429 cfs with a maximum flow of 779 cfs, was the largest recorded daily average flow in Cooper Creek since 1961 and likely rearranged some of the habitat that was measured during the habitat inventory. However, it is generally believed that the ratio of habitats that existed before the flood still exists, as there was no known catastrophic input of sediment or other event that would act as a stream network-changing event. Therefore, data collection will proceed as scheduled, although selection of appropriate cross-sections will be carefully applied. This general guideline will be followed in the event of another large flood during the course of the study.

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